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ABSTRACT

The conclusions are reported of a survey of aspects of school and classroom environments and their effects on student achievement as these effects were indicated by data from the International Association for the Evaluation of Educational Achievement (IEA) study of schools in the United States. Only the resource levels and activities generally available in the school as a whole could be investigated. Subjects were 10 or 14 years old or were high school seniors. No association was found between achievement levels and either hours of school per week or weeks of school per year; but hours in specific subject areas had consistent positive relationships with achievement and often with positive attitudes in those areas. There appeared to be threshold levels of resources below which adequate school achievement could not be accomplished; but schools with high resource levels exhibited a full range, low through high, of achievement. The relationships between achievement and student activity or participation, degree of structure, and amount of evaluation activity in the schools were complex. (Author/CTM)

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School and Classroom Processes:

A Secondary Analysis

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The purpose of this investigation was to explore aspects of the school and classroom environment which impinge directly on pupils' learning, specifically, the process of schooling. The main avenue through which this was accomplished involved a reanalysis of data from surveys conducted by the International Association for the Evaluation of Educational Achievement (IEA). Measures of the provision of instructional resources to pupils, and indices of classroom activities were related to both cognitive and affective attainments in reading and science.

School and Classroom Process

The focus on instructional process represents an attempt to understand better the functional relationships between events external to the learner and his/her cognitive functioning. In earlier years, educators studied status characteristics of teachers, schools and homes, such as class size (Blake, 1954; Kidd, 1952), socioeconomic status (Averch et al., 1972; Bloom, 1965; Coleman et al., 1966) per-pupil expenditures (Bidwell & Kasarda, 1975; Kiesling, 1967, 1969), teachers' years of education or professional experience (Averch et al., 1972; Coleman et al., 1966), and correlated these with student or school performance. While moderate relationships were often found (e.g., for SES or expenditures) more specificity was necessary. These variables pointed in important directions, but did little to explain how some pupils were coming to learn more than others. Moreover, these studies provided even less information concerning aspects of the school environment that could be manipulated by teachers and administrators to optimize pupil performance.

The study of process characteristics of any developmental setting demands emphasis on explanation and analysis of variables operating within the setting; status characteristics are merely descriptive. In examining the school setting, Bloom (1972) concludes "it is not what teachers are like but what they do in interacting with their students in the classroom that determines what students learn and how they feel about learning and about themselves" (p. 8). And indeed there has been a focus on teacher-pupil interactions and on classroom instructional processes in recent years (e.g., Good, Biddle & Brophy, 1975; Dunkin & Biddle, 1974; Rosenshine & Furst, 1973).

Two major theoretical developments have helped to direct the study of classroom processes. Carroll (1963) forwarded a model of learning as a direct function of the amount of time the student spends in learning, and an inverse function of the time needed to learn. The time needed is further described as a function of student aptitudes and the quality of instruction, which implies, among other factors, "the student must be put into adequate sensory contact with the material to be learned" (p. 726). The time spent in learning is determined by opportunity -- the provision of resources and time for learning -- and by the individual's perseverance. All of these factors stress the importance of the student's active involvement with material to be learned, and with resources and activities to facilitate that involvement.

Bloom (1976) underscores the importance of student involvement in a model positing cognitive entry behaviors, affective entry characteristics, and quality of instruction as major determinants of achievement. "Quality of instruction ... has to do with the cues or directions provided to the learner, the participation of the learner in learning activity (covert or overt), and

the reinforcement which the learner secures in some relation to the learning" (p. 115). Again, all aspects connote appropriate instructional materials and participatory activities. Attention is also directed toward evaluative and testing activities which comprise part of a class' reinforcement structure.

The process model underlying the present investigation follows the guidance of Bloom and Carroll. Specifically, this investigation focused on the instructional resources -- time, materials and personnel (human resources) -- provided to classes and pupils, and the types of learning activities in which pupils were engaged. This model is specified as Achievement = f (Resources, Activities).

Three general questions were investigated:

(1) What is the relationship between the use and distribution of instructional resources and students' cognitive and affective performance? In particular, are there threshold levels of resources below which pupil achievement is inadequate, or attained at the cost of strongly negative attitudes toward school subjects?

(2) What is the relationship between learning and evaluation activities and students' cognitive and affective performance? Additionally, is there an optimal activity level; that is, can too high or varied activity levels inhibit cognitive attainment?

(3) Is there an interaction of resource utilization and activity structure which mediates learning? Specifically, what particular combinations of the two domains maximize student achievement?

Data for the Investigation

Subjects

Data for the study were drawn from the data bank of the Six-subject Survey conducted by the International Association for the Evaluation of Educational Achievement (IEA) in Stockholm. The total IEA survey involved children at three age levels in 22 countries, their homes, schools and teachers. Summary reports were published by the IEA investigators (e.g., Comber & Keeves, 1973; Purves, 1973; Thorndike, 1973), following which the data files were opened to other researchers for selected reanalysis.

The primary analysis for this study involved the American samples at all three age levels: Population I includes ten-year olds (pupils between 10-years-0 and 10-years-11 months at the time of testing); Population II comprised of fourteen-year-old students; and Population IV comprised of high school seniors, who are predominantly seventeen-year-old students. Since pupils begin kindergarten at either age four or five, depending on their birthdates, pupils who are age ten in May are found in both grades four and five, while age-fourteen pupils are in grades eight and nine. This provides an advantage to the present research since data are available on comparable studerts who differ mainly in a single year's school attendance.

The IEA data were collected in a two-stage sampling plan to represent the nationwide population of children at each age level. Schools were selected from towns and cities or else from non-urban counties as defined by the U.S. Census. The communities were stratified by size and by an index of socio-economic status; a fixed proportion of schools was selected from each classification. At the second stage, students were selected from within a school with probability inversely proportional to the school size, so that about equal numbers would be drawn. Also in each school a sample of teachers was drawn at each participating grade level, according to the subject area taught. Unfortunately, the teacher samples were drawn independently of the student samples, so that teachers of some of the students in the sample may not be included, and some of the teachers studied may not have had students who were sampled.

For this investigation the sample was further specified to include only pupils who participated in the IEA testings in science, reading comprehension and literature. At the fourteen- and seventeen-year-old levels, the same students provided data in all three subjects, while separate groups of ten-year-olds took the science as opposed to the language ("mother tongue") tests. All testing was conducted at the end of the spring semester of 1970.

At the 10-year-old level the sample consists of 5035 pupils in 260 schools; at the 14-year level 5792 students in 145 schools; and at the senior level 4690 students in 116 schools. The sample represents students at all socioeconomic levels, and is approximately half male and half female. About one-third of the students is in the lower grade for their age group (grade 4 for ten-year-olds and grade 8 for fourteen-year olds) and about two-thirds in the upper grade. Very small percentages are outside the two-grade range and the few such data collected in the IEA survey were deleted from the present analysis. At the Population I and II levels, the samples represent the entire respective national age cohort; at the Population IV level however, only about 70 per cent of American youngsters remain in school, so that the samples are representative only of that subpopulation.

Measures

The IEA testing included achievement and attitude scales administered to each student, as well as a Pupil Questionnaire requesting information about the student's home background, study and reading habits, and the course work taken currently or in past years. In addition, a Teacher Questionnaire was administered to every teacher sampled, requesting information about school policies, including general curriculum and instructional programs, and information about the types and sizes of the programs available.

Dependent variables. The dependent variables chosen for the study are cognitive and attitude measures in reading and science. Each student's achievement is characterized by a profile of scores, used much as a single score is used elsewhere (e.g., Coleman et al., 1966; Plowden, 1967). The achievement profiles for each student consist of scores on twelve scales. The cognitive reading outcomes are results on the IEA Reading Comprehension Test (1) and the Word Knowledge Test (2). The affective measures are a Reading Attitude scale (3) and students' responses about the Hours Spent Reading for Pleasure (4). Science cognitive results were obtained on Biology (5), Chemistry (6), and

Physics (7) subtests, with additional results (scale 8) in Earth Science for Population I and in Practical skills for Populations II and IV. Science attitude outcomes are scores on four scales -- Like/Dislike (9), Science Activities (10), the Importance of Science in the World (11), and Difficulty Expectations (12).

Independent variables. Twenty independent variables for the investigation reflect the teachers' use of resources and instructional activities in the classroom. Six measures of human resources were obtained from the School Questionnaire and included: (1) the range of grades spanned by the school; and (2) a principal component school-size composite, formed from the number of boys and girls attending the school, and the number of teachers; (3) the number of teachers per pupil based on the total counts; (4) the number of academic specialists (librarians, laboratory assistants, teacher aides, etc.) per pupil; (5) the number of psychological specialists (counselors, psychologists; etc.) per pupil; and (6) the availability of remedial teaching in mathematics and science, or else in reading and mother tongue.

There were five measures of time as a resource. These included three global scales of (7) the number of hours per week which pupils must attend school; (8) the number of weeks in the school year, and (9) the last grade level at which science or literature is a required subject. Also included were two more specific scales which represented student time devoted to studying reading and science, both in school (10) and out (11).

Three variables from the IEA files provided some information about material resources and their uses. At the teacher level these were: (12) availability of textbooks and (13) availability of dictionaries and book corner or library for the class. The availability of certain "cultural amenities" (e.g. museum, zoo, theater) was also recorded at the school level (14).

Four activity scales represent the nature and structure of student instruction, while two additional activity scales reflect the nature of testing and evaluation, as part of the instructional procedure. Specifically, these variables were: (15) the extent of individualized instruction, reflecting the usage of individual materials and small-group and tutorial methods; (16) student participation in learning assessing the use of printed drill, questioning and discussion periods, and laboratory work; (17) "traditional" and highly-structured instruction reflecting high amounts of textbook study and teacher lecturing; (18) a variety score reflecting the range of teaching activities engaged in to a high degree. The testing variables are (19) structured assessment, reflecting the use of standardized, essay and objective tests; and (20) "other assessment" reflecting the extent to which homework and course projects and papers are used to evaluate pupil progress.

Control variables. Several other measures are employed in the analysis as control variables. "Home background" is a weighted composite of the occupational rating of each student's father, the years of mother's and father's education, and the number of siblings. The selectivity of the school was rated by counting the number of admissions criteria (e.g., prior achievement, interview, entrance examination) necessary in order for a

student to attend. At the same time, the (lack of) freedom for teachers within a school to design curriculum and organize instructional activities was scored as the proportion of teachers who reported feeling restricted in this manner.

Analysis and Results

Means were computed for all boys and all girls in each school at each grade level, and these became the units for all further analysis. It was necessary to aggregate the data to this level since teachers were not matched with pupils in the original IEA sampling, but separate teacher and pupil samples were drawn from each school. Thus only the resource levels and activities "generally available" in the school could be investigated; these could not be attributed to any individual teacher and their direct effects on individual pupils could not be observed. This proved ultimately to be a serious handicap to the present investigation. Most correlations across schools were low or zero, as might be expected on measures where the important differences are between classes or teachers.

The correlations and regressions of achievement and attitudes on the resource variables gave generally low or zero results. In particular the measures of human resources showed no linear correlation with schools' mean achievements. However, the resource measures (e.g., teacher/pupil ratios, number of specialists per pupil) were very global and might well be important factors for certain pupils; this breakdown was not possible from the IEA data. Likewise material resources showed little linear association with school outcomes.

The finding of no association between achievement levels and hours of school per week or weeks per year is important however, in indicating that school differences must be a function of how the time is used rather than how much is allocated. On the other hand, the measures reflecting students' amount of instruction and homework in specific subject areas have consistent positive relationships to achievement and in many instances to attitudes as well! The importance of time usage within school is underscored as a resource worthy of still further exploration.

The activity dimensions likewise proved to have low or zero correlations with achievement when the analytic units were school averages. One exception to this involved the relationships with student participation in learning activities and the degree to which instruction was structured and "traditional." Participation showed positive relationships to achievement in science, perhaps a highly participatory subject area, and negative relationships with reading. Traditional and more structured instruction had the reverse pattern -- positive correlations with reading and negative with science. While these patterns were clearest at the later grade levels (grade twelve), they suggest strongly that the antecedents of performance vary with the subject area. Few empirical investigations have examined systematically the nature of the content to be mastered in various disciplines and the required variations in instructional approach.

The frequency of highly structured evaluations was also differentially related to science and reading, but to attitudes more than cognitive attainment. Frequent structured evaluations, which correlate positively with biology attainment, accompany low attitudes toward science and positive attitudes

toward reading. The science results in particular are striking in the suggestion that experiences which operate to increase learning may simultaneously depress attitudes. The possibility that degrees of structure and regulation yield these diverse outcomes needs to be given consideration in further research.

Scatterplots of several instructional resources and school achievement levels yielded, in many instances, a more complex but consistent pattern. Schools having low resource levels also had low mean achievement levels; schools with higher resource levels exhibited a full range of (low through high) average achievements. The data suggest that certain threshold levels of particular instructional resources provide necessary but not sufficient conditions for high achievement to be attained. In every case, the resources which displayed this "three-locus" scatter pattern were those that relate to individual students within the school (e.g., every student having his/her own text, students having regular science lessons) rather than more global ratings (e.g. length of school year, cultural amenities available in the neighborhood). The pattern appeared for achievements both in science and reading.

The schools were partitioned into those having low resource levels, and those having high resource levels but with low and high achievement, respectively. The differences between the latter two groups were examined in particular. At grade four, the only discrepancies between those schools with adequate resources but with low and high achievement levels are found in the home backgrounds of the children. At grade eight and nine, differences are also found in the time allocated to study of school subjects. By grade twelve, in addition to home backgrounds and study time, several of the instructional activities also distinguish the two groups, most notably the extent of student participation in learning and curricular variety. The activity structure of the school and classroom as studied in this context emerges as more important to learning as youngsters proceed to the upper grades. This is contrary to the emphasis in classroom research, which focuses most often on primary instruction. Thus, a closer look at the process of learning especially student participation in the upper grades is suggested.

Discussion

Only partial answers to the three major questions posed at the outset of this investigation were possible from reanalyzing the IEA school data. First, there are indeed noteworthy relationships between the distribution of instructional resources and students' cognitive and affective performance. Those resources that affect directly each pupil have the clearest associations with attainment, and in particular those relating to the utilization of time both within and outside the school day.

There do seem to be "threshold" levels of resources, below which adequate pupil or school achievement cannot be accomplished. These must be seen as a first priority for further investigation. The IEA data, measured on global ratings and without the possibility of matching students with their teachers or classrooms, can only provide indirect answers to these questions. In particular, research is required to find ways to allocate time, human and material resources to "optimize" learning -- that is, to achieve an adequate attainment level for each pupil at reasonable cost.

Second, the relationship of the activity structure and pupil attainment is less clear from these data. However, there are associations between student participation, the degree of structure, and evaluation activities which are worthy of investigation at a pupil or class level. Particular attention should be given to those activity structures appropriate for different subject areas, and those that relate to students' atttitudes as opposed to cognitive performance. Indeed part of the "cost" associated with attaining high performance levels may be a depression in attitudes, we must consider whether this is a price worth paying.

Finally, it does seem that there are important interplays of the resources available for instruction and the ways in which they are used, i.e., the activity structure. The IEA reanalysis suggests that these are stronger in the later years of schooling, where students themselves have more curricular choices, and further research should concentrate at these levels. Research should be directed toward increasing the "efficiency" of instruction through appropriate use of both resource and activity levels.

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